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Drought Risk Management for Beef Cattle Farms

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One of the most challenging aspects of owning and operating any farming operation is dealing with uncertainty. Uncertainty on the farm comes in many forms; livestock health, feed prices, fuel prices, market prices, and weather to name a few. Over the past decade, the prevalence and impact of drought on agriculture has dramatically increased, thus adding further uncertainty to farmers' decision-making processes. Drought and the associated loss of productivity is a real risk scenario that all farmers must face. With this inherent risk, one must protect their farm and the environment it impacts through a sound decision-making process that factors in uncertainty and scarcity of critical resources.

Once a drought occurs, it can be difficult to effectively manage your resources and overcome the conditions that drought creates. At the heart of effective drought management is preparedness. A systems-management approach is an ideal tool for drought preparedness, as its goal is to improve each component of the farming operation (soils, forages, facilities, stock, etc.) and improve the connections between the components (i.e. the system). The goal of this publication is to aid beef producers in implementing best management practices (BMPs) that take a systems approach to maximizing farm water use efficiency, while operating under the assumption that water is becoming an increasingly uncertain resource that is vital to the future of the farm.

Basic Principles of Drought Management

Farmers in Kentucky experience moderate agricultural droughts every few years. Between those years, it is not uncommon to have regional or localized droughts within the state. Due to the uncertain and unpredictable nature of droughts, a proactive management strategy can aid beef producers in protecting their resources (soil, water, livestock, etc.). Drought preparedness starts with the implementation of BMPs on Kentucky's farms by utilizing an Ag Water Quality Plan.

Figure 1. Continuous grazing (field on the left) increases compaction and reduces infiltration as compared to rotational grazing (field to the right). Photo by Randy Smallwood

Two of the most essential resources to any producer are soil and water. These components of the farm are often taken for granted due to their seemingly endless availability. The complex interaction between soil and water has many aspects to consider when formulating BMPs to prepare for drought. For example, the texture of a soil greatly influences the water holding capacity. Depending on ground cover and the soil texture, erosion takes place in various ways and at varying rates. Sheet and rill erosion occurs on bare soil or where soil is not stabilized by root systems or protected with a cover crop. Gulley erosion is more common in pastures with concentrated flows. When erosion occurs, runoff increases and less water infiltrates the soil. The soil that is transported through erosion is generally the more fertile, organic matter-rich portion of the soil, thereby depleting the remaining soil of nutrients and organic matter. Preventing erosion and maintaining high soil organic-matter content increases soil water-holding capacity and fertility, thus maintaining plant growth for longer carrying capacities in drought situations.

Overgrazing and compaction are stresses that lower water-holding capacity, infiltration rates, organic matter content, and yield. At the same time, overgrazing and compaction increase pasture deterioration, evaporation, and runoff. Rainfall also plays a critical role in shaping these soil characteristics. Depending on the intensity and duration, raindrops can hit exposed soil with an explosive effect, launching soil particles and degrading soil structure. Once dry, the surface of the soil can experience hydrophobic (water repellent) crusting, which can further limit infiltration of

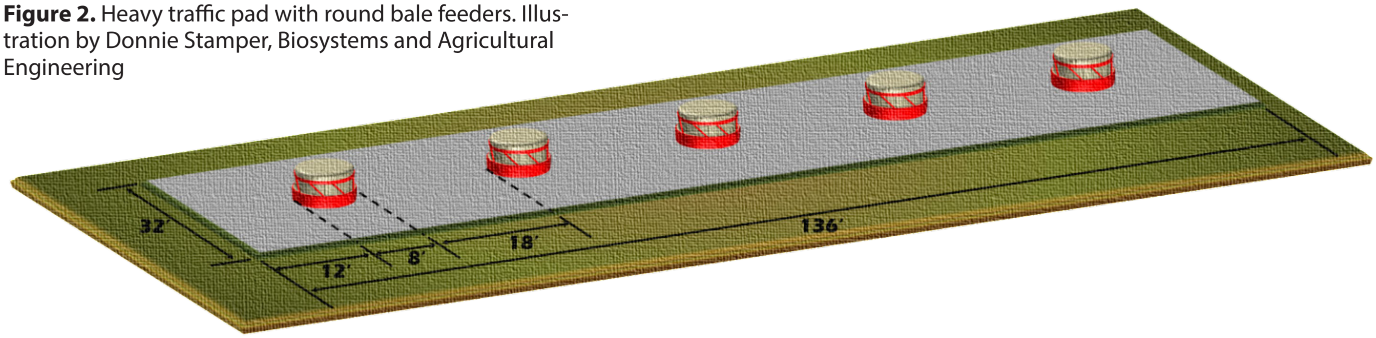


Figure 2. Heavy traffic pad with round bale feeders. Illustration by Donnie Stamper, Biosystems and Agricultural Engineering

water. All of these effects will be more problematic on sloped pastures. Overtaxing soil resources can and will lead to damage. In extreme cases, the damage caused can be extremely difficult, if not impossible to correct. Simply removing the cattle or allowing natural methods to correct the damage may not work or may take many years to correct using natural forces. In some cases, improving infiltration rates requires mechanical correction. All of these negative effects are magnified when drought strikes. Producers should implement practices that preserve topsoil and increase organic matter content, while avoiding compaction. The following principles and associated BMPs can help you protect your soil and water resources in a manner that will prepare your farm for the possibility of drought.

Solutions

Implementing BMPs associated with the following "Principles of Drought Preparedness" can improve your farm's ability to cope with the additional stress a drought can add to your soil, plants, water, and livestock.

Figure 3. A single pass with a tractor on this clay soil type will reduce forage yields for many years or even permanently. Photo by Bob Carey

Principles of Drought Preparedness

1. Rotational Grazing
2. Soil Compaction
3. Vegetative Terracing
4. Forage Diversity and Fertility Management
5. Stocking Density
6. Water Sources
7. Shade
8. Drought Resistant Stock

1. Rotational Grazing

Rotational grazing is an ideal practice to prepare for drought. Figure 1 shows the difference between continuous and rotational grazing on adjacent farms. Grazing practices directly affect soil properties, such as infiltration (the process by which water on the ground surface enters the soil.) A rainfall infiltration test simulating a one-inch rainfall event was conducted on these soils. Infiltration in the field on the right required 12 minutes, whereas the field on the left required 28 hours. This represents a 140-fold increase in time to infiltrate. The slower the infiltration rate of a soil, the greater the amount of runoff. Increased runoff associated with decreased infiltration may lead to increased erosion, with associated loss of nutrients and decreased plant available water. Research has shown that higher runoff rates and exposed soil increased erosion by 235-fold. A ground cover percentage of 75 percent is considered the critical value below which runoff and soil loss increases significantly. Taller vegetation above ground equates to a deeper root penetration below ground. Deeper roots provide more drought tol-

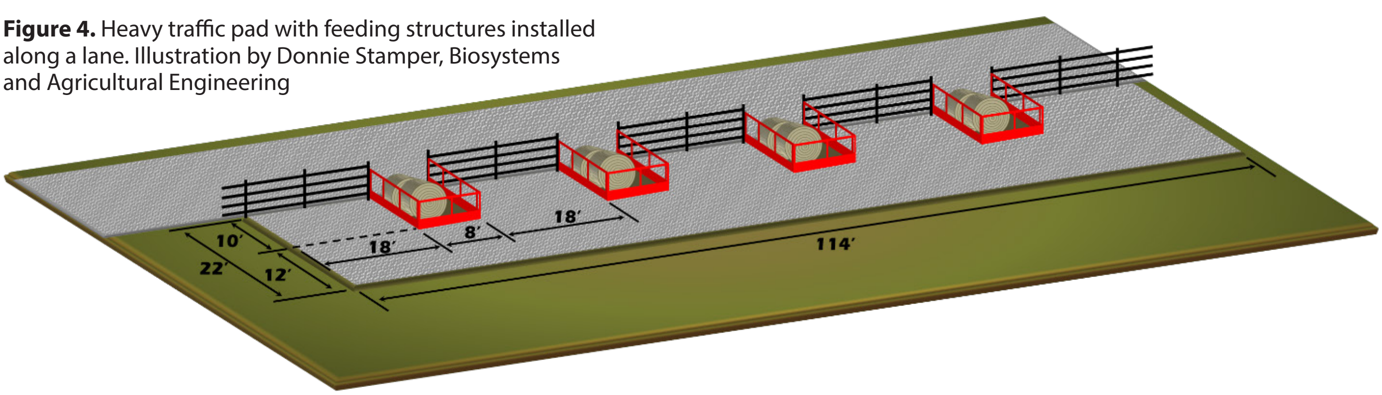


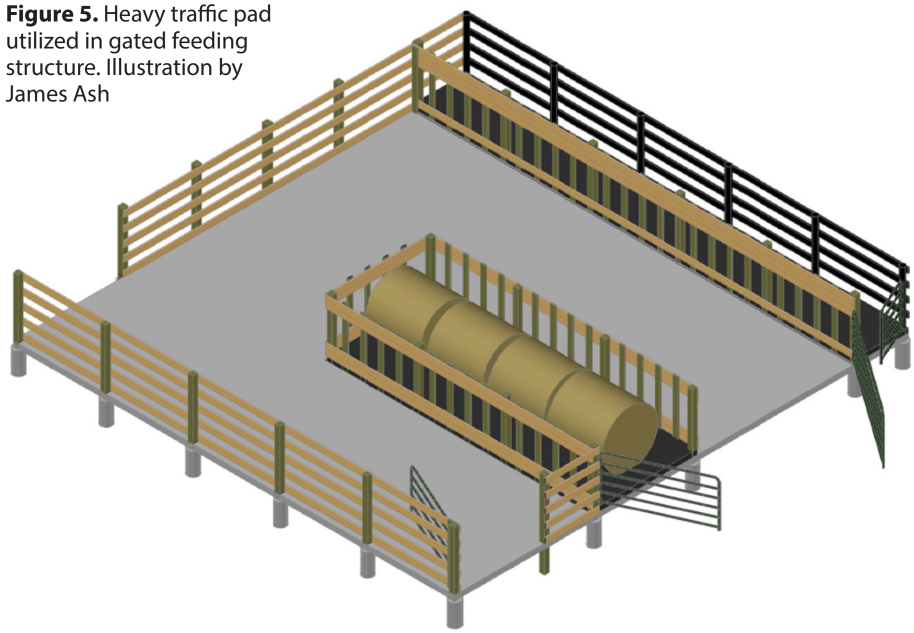
Figure 4. Heavy traffic pad with feeding structures installed along a lane. Illustration by Donnie Stamper, Biosystems and Agricultural Engineering

erance than shallow roots by improving soil stability (resistance to erosion) and maintaining sufficient infiltration rates that keep water from running off.

The proper timing of rotational grazing is critical to the success of a grazing plan. Overgrazing can lead to slow pasture recovery times. Vegetation is more responsive when pastures are rested within a rotational grazing system. Ideally, pastures should be small enough that cattle can fully utilize available forages without over grazing (grazing forage no lower than 3-4 inches) and move onto the next pasture in the rotation. Each pasture in the rotation needs roughly four weeks of rest between periods of grazing. If pastures are slow to recover during periods of unexpected or late summer drought, ultimately, a producer may lose a valuable asset in their rotational grazing plan. What needs to happen, if pastures are slow to recover, is that the producer needs to add paddocks into the rotation (which may not be possible), reduce stocking rates (which is hard in a cow-calf situation), or start feeding in an enclosed dry lot or sacrifice pasture. What some producers do is open all the gates and abandon their pasture rotation. This is the worst thing to do because, if the dry spell continues, the producer will now overgraze the whole farm. It may also pay to defer grazing on one paddock in the spring and early summer to use as a "drought" or "dry spell" pasture in case a period of drought occurs. This could be a field that is too rough to use for hay or a thin soiled hill that needs extra recovery time during normal moisture conditions. During a severe drought, producers should consider getting cattle off pastures and feed hay using winter feeding structures, which will be discussed later.

Rotational grazing helps maintain a constant vegetative cover, which is critical to the prevention of erosion and reduction of runoff. Producers should strive to maintain the integrity of pastures used for rotational grazing by limiting animal and vehicle traffic during and after wet periods by using designated areas for feeding (i.e. spring and winter-feeding). Further information on planned grazing can be obtained from the UK Cooperative Extension publications *"Extended Grazing and Reducing Stored Feed Needs"* (AGR-199), *"Stockpiling for Fall and Winter Pasture"* (AGR-162), and *"Rotational Grazing"* (ID-143).

Figure 5. Heavy traffic pad utilized in gated feeding structure. Illustration by James Ash



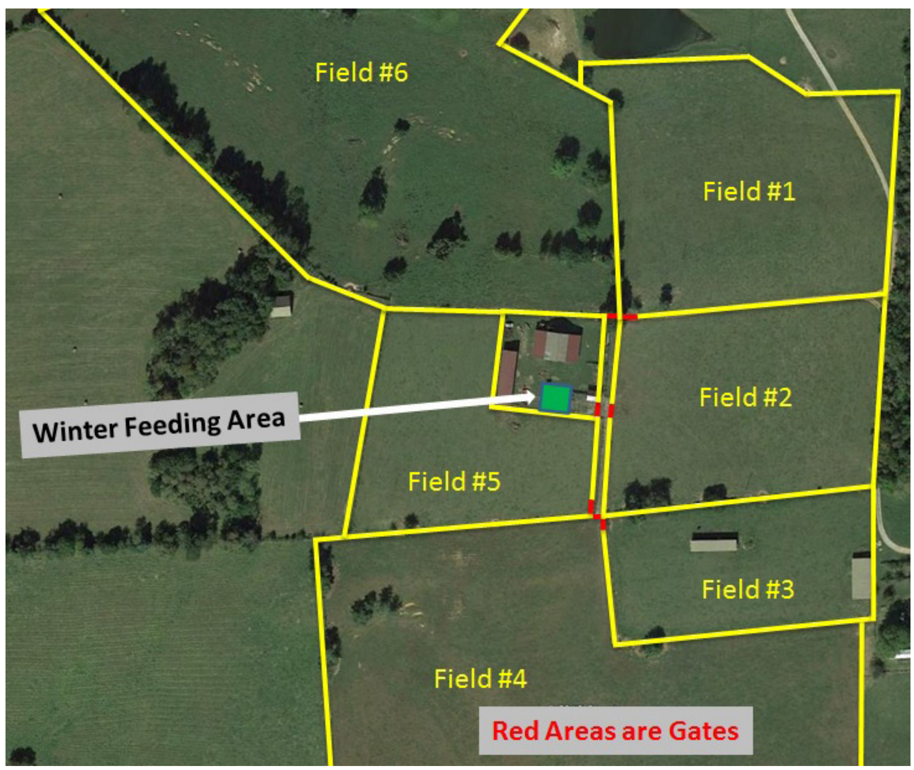


Figure 6. An example of a winter feeding structure that is used as a centralized hub for serving multiple pastures and groups of cattle for feeding and handling. Illustration by Lee Moser

2. Soil Compaction

A beef producer can preserve pastures and significantly reduce soil compaction by limiting cattle to improved surfaces (areas reinforced with geotextile fabric and compacted gravel) that can support their weight during saturated conditions. This practice will limit the creation of mud, reduce forage losses, and improve beef cattle performance. This can be accomplished by systematically installing all-weather surfaces, which are then used for winter feeding areas (Figure 2). However, this system requires a tractor to enter the pasture.

When a tractor enters a field or pasture during saturated conditions, the stress of the load can, depending on the soil type, cause semi-permanent to permanent damage to a soil (Figure 3). An improved winter-feeding system utilizes winter feeding structures, heavy traffic pads, or all-weather surfaces which could be accessed without entering pastures. A fence-line feeder (Figure 4) allows cattle to be fed without entering the pasture. Figure 5 shows an example of a winter feeding structure that could be centrally located, allowing access to multiple pastures and groups of cattle for feeding (Figure 6). This management system forces cattle to come to a feeding area for a designated period allowing access from a hardened road or barnyard. This structure could also be close to handling and care facilities, creep feeding areas, and hay storage. Further information on all-weather surfaces and feeding structures can be obtained from the UK Cooperative Extension publication "*Strategic Winter Feeding of Cattle using a Rotational Grazing Structure*" (ID-188).

If a tractor must go in a field, producers should use an established path because the most damage (compaction) occurs on the first pass. The proper placement of the first pass or any roads (a concept called controlled traffic) into a pasture is critical to minimizing soil compaction. Avoidance of wet areas and utilization of areas that have well drained soils helps avoid compaction from both vehicle traffic and livestock. Figure 7 shows how wet soils are more susceptible to damage from heavy traffic than soils that are well drained.

Figure 7. This site (with poorly drained soils) is not suitable for vehicles or feeding during the winter season. Photo by Amanda Gumbert

Another strategy for reducing soil compaction involves minimizing vehicle impact on soil structure by reducing axle loads. Operating a smaller tractor when possible or an all-terrain vehicle (ATV) with wide profile tires (which have a reduced axle load and distribute their weight over a large area) causes less soil compaction.

3. Vegetative Terracing

Un-compacted soil is much more resilient to potential drought conditions. It can store available water when precipitation occurs and has higher fertility than compacted soil, therefore, efforts should be made to avoid compaction. Areas that are heavily compacted through rutting during wet conditions can take years to recover naturally. They often require manipulation to return the soil

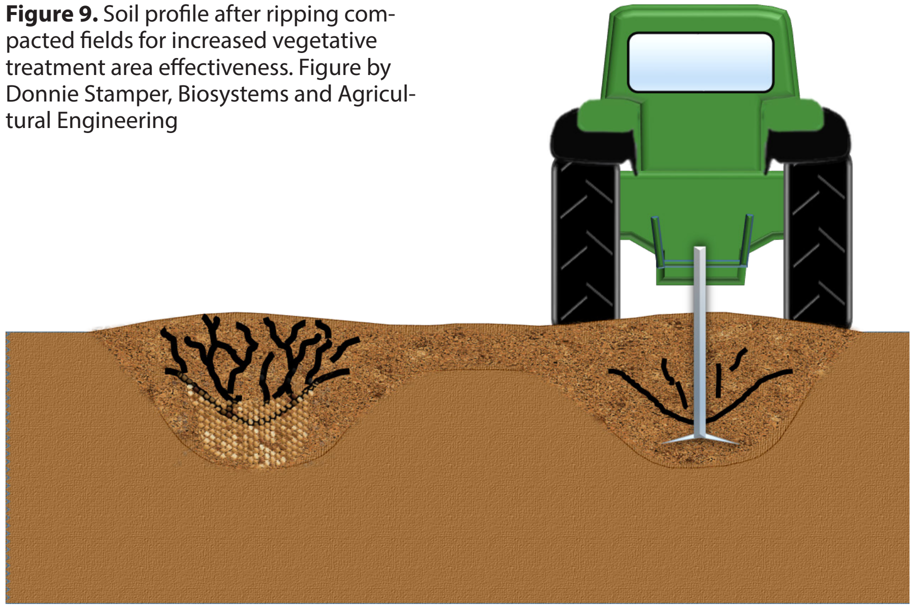
Figure 8. Ripping compacted soils along the contour of the slope can increase infiltration and reduce runoff. Photos by Dan Miller

to pre-compaction levels of water holding capacity, infiltration rate, and soil organic matter content.

Ripping or subsoiling pastures along the contour of a slope creates terraces. These terraces can create a vegetative barrier, which reduces the effective length of a slope, allows runoff to infiltrate, and increases the water holding capacity of the soil (Figure 8). The practice of tilling a pasture with a ripper should be accomplished to a depth of no more than 18 inches. Research shows success with breaking up the soil profile with 3-foot spacing between shanks or parallel passes (Figure 9). The ideal spacing will depend on the type of tillage tool. The distance between parallel passes can be increased when using rippers with winged shanks. A good rule of thumb to use with single shank rippers is to make parallel passes by driving over a tire track of the previous pass. Tillage must also be conducted at the right moisture content to prevent smearing (smoothing and sealing caused by applying pressure to wet soils). The benefits of this process can be long lasting if traffic is controlled.

One of the best places to implement this concept is below a feeding area (Figure 10). This practice allows the nutrients and solids in runoff to be utilized and deposited, respectively, in a buffer area. This area could then be creep grazed by calves or flash grazed to utilize the forage, while still maintaining a tall stand for filtering. This practice is known as a vegetative treatment area.

Figure 9. Soil profile after ripping compacted fields for increased vegetative treatment area effectiveness. Figure by Donnie Stamper, Biosystems and Agricultural Engineering



One of the best times to renovate a pasture is after a drought. Renovation or reseeding of a pasture should be conducted before chisel plowing or ripping, because once the soil is loosened by tillage, it can easily be compacted if tractor traffic is applied in the same area. The process of fertilization, ripping and seeding a pasture should be considered as a best management practice.

4. Forage Diversity and Fertility Management

Plant species peak in productivity at different times throughout the growing season. The nutritional value of plants is generally at its highest during this peak in rapid growth. Growing a diverse set of forage species in pastures allows for maximized grazing efficiency. Maintaining diverse forage cover helps improve the likelihood that pastures will remain productive, nutritious, and resilient if drought hits and normal precipitation patterns become altered. However, optimum plant growth cannot be achieved without optimum fertility and soil conditions. Producers should get into the habit of soil sampling their pastures and applying the recommended rate of nutrients and lime to achieve optimum yields. A recommended sampling interval of every two years should be used.

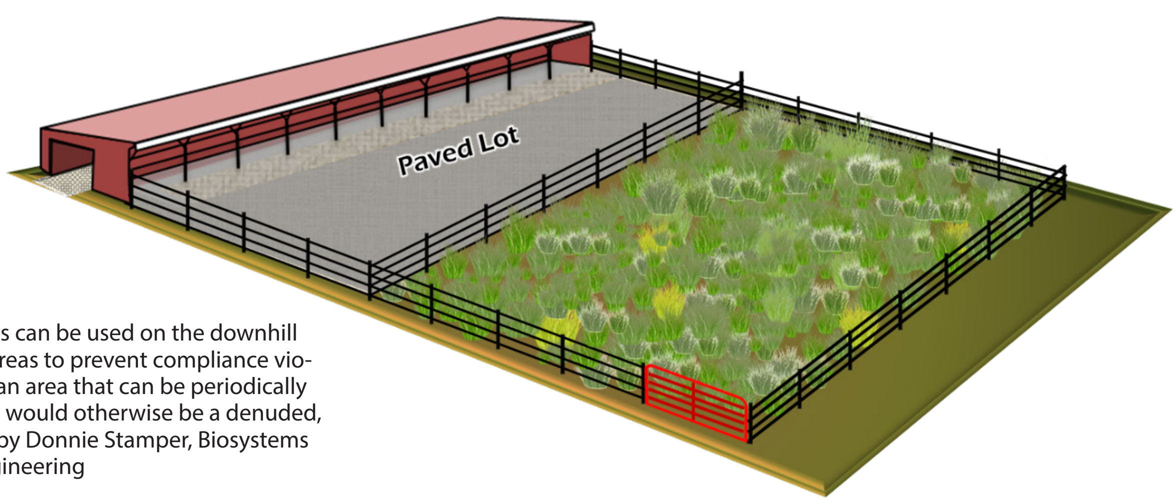


Figure 10. Filter strips can be used on the downhill side of production areas to prevent compliance violations and provide an area that can be periodically flash-grazed in what would otherwise be a denuded, muddy area. Figure by Donnie Stamper, Biosystems and Agricultural Engineering

Applying fertilizers based on soil test recommendations can save producers money. Over fertilization, especially in the case of phosphorus, should be avoided. High soil test phosphorus (STP) can actually weaken soil, making it easier for mud, compaction, and erosion to occur, which can hinder future productivity. High STP also causes the soil to produce more apatite (calcium phosphate) and magnesium phosphate, which ties up calcium (Ca) and magnesium (Mg) in the soil, reducing the calcium and magnesium content in forages. If fertilizers or manures are over-applied, the forage may not provide enough calcium or magnesium for lactating cows.

5. Stocking Density

Understanding and managing the resources of a farm are essential to achieving proper stocking densities. Practicing restraint and stocking the farm to levels that are sustainable over the long-term can ensure the continuation of a pasture-based operation during drought conditions. Determining a farm's equilibrium, which is based on its resources (soil and vegetation), ensures the farm will operate at maximum efficiency. Forages should be fully utilized without overgrazing a pasture. Stocking densities should be adjusted in a manner that minimizes degradation to soil, vegetation, and water resources.

6. Water Sources

Traditionally, direct access to streams and ponds has been used as a cheap and easy means of watering livestock. Current BMP guidelines emphasize the reduction of impacts to streams and water resources by limiting direct access from livestock and reducing nutrient delivery. When utilizing a rotational grazing system and attempting to reduce degradation of wet areas, livestock should not be given direct access to ponds and perennial streams.

During droughty periods, many surface water sources may not be flowing. Several practical, reliable methods exist for alternative water sources and distribution systems including: city water, traditional AC pump systems, ram pumps, sling pumps, nose pumps, solar operated DC pumping and storage systems, gravity fed tire waterers, and rainwater fed storage systems. These alternative methods should be incorporated into a rotational grazing program to provide water in areas where it may not have been previously available. Alternative water sources are also more useful if the pond or creek goes dry during periodic dry spells or drought. Providing alternative water sources can reduce the distance an animal must travel to and from a watering source and improve overall grazing efficiency. The best option for your farm will depend on the layout of your farm, livestock water requirements, cost, and availability of resources. Investigating these aspects can help you decide on which alternative water source or combination of sources can be utilized in your pastures.

Harvesting rainwater from buildings provides an alternative source when groundwater is unsuitable for use or completely unavailable. It can also be used to supplement city water supplies and thereby reduce energy and utility bills. Rainwater harvesting reduces storm water runoff, reducing the potential of soil erosion and nutrient delivery to nearby waterways. Diverting and utilizing clean water from roofs may reduce the volume of water that can become contaminated by animal confinement areas or allow for use of a pasture that has limited or no access to water.

7. Shade

The next systematic BMP for drought preparation is providing shade to reduce water requirements for beef cattle. Research studies have demonstrated that cattle provided with shade and shelter will outperform cattle without shade, while lowering their water intake requirement and aiding in prevention of heat stress. Heat stress increases respiration and water intake, decreases feed intake and body condition, reduces fertility and milk production, and leads to weight loss. Heat stress can be intensified if cattle are grazing on endophyte-infected fescue. Shade can come from natural sources, permanent structures, or portable structures. When natural sources of shade are not available or occur in sensitive areas, producers should provide shade for their cattle, using these guidelines:

- Locate shade structures on dry sites
- Move portable shade structures regularly
- Choose sites with good ventilation
- Consider Thermal Heat Index (THI) (humidity and temperature) when evaluating shade needs
- Keep shade structures away from sensitive areas like hillsides, streams, and sinkholes

Further information on the importance of shade and utilizing shade structures in your pastures can be obtained from the UK Cooperative Extension publication "Shade Options for Grazing Cattle" (AEN-99).

8. Drought Resistant Stock

The cattle breed that a producer selects for his/her farm should, at a minimum, have the traits to withstand Kentucky's sub-humid climate. If you are purchasing cattle for your farm, choose cattle that have the genetic background that originates from the South rather than the North. This does not necessarily mean eared cattle (like Brahman). Drought resilient traits (genes) can be introduced into many breeds through a selective breeding program. Phenotypes with genetic adaptation to drought can improve the overall hardiness, heat/insect resistance, and metabolic efficiency of cattle in a herd that exist under occasional to regular drought conditions. Crossbreeding can also impart hybrid vigor upon offspring. In beef cattle, hybrid vigor is often exhibited in heavier weaning weights, increased milk production, greater calf vitality, higher fertility, and increased disease resistance. Producers should be cautious when increasing milk production. It will lead to more energy/feed to maintain a cow that is a heavy milker. Having a heavy milker during a drought may require that the producer adapt their management to reduce forage consumption by the cow by weaning early.

Summary

The practices suggested throughout this document are presented as a systematic approach to dealing with drought in Kentucky. They require a producer to implement adaptive management strategies that modify the operation to the environment instead of modifying the environment to the operation. Practices that increase, secure, and optimize the available water on the farm should be chosen to increase the effectiveness and efficiency of the operation. Producers should prioritize the areas that are the most limiting production areas through self-evaluation and implement additional BMPs or practices to address the limitations. Providing a source of water makes a field usable, but may reveal soil fertility issues or the need for improved forages, indicating that this is a dynamic process. More than likely, the processes and practices implemented in this procedure compliment a producer's agriculture water quality plan. The beauty of this process is the improvement of the overall productivity of the farm, while maintaining and improving the integrity of the environment.

Additional Drought Resources

UK Ag Online Publications: http://www2.ca.uky.edu/agcomm/pubs.asp

National Drought Mitigation Center (NDMC): http://drought.unl.edu/ranchplan/Overview.aspx

U.S. Drought Monitor: http://droughtmonitor.unl.edu/

National Integrated Drought Information System (NIDIS): http://www.drought.gov/drought/

North American Drought Monitor (NADM): http://www.ncdc.noaa.gov/temp-and-precip/drought/nadm/

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